VILLAGE OF HARRISON HOT SPRINGS

CHLORINATION/DECHLORINATION EVALUATION

Inspection by:

G. Bradshaw
A. David
D. Walker

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VILLAGE OF HARRISON HOT SPRINGS STP

The chlorination/dechlorination system at the Harrison Hotsprings Village sewage treatment plant was evaluated on two one-day inspections by EPS personnel (October 7, October 14, 1982).

The purpose of the evaluation was to determine the effectiveness of the dechlorination mode on reducing the level of chlorine entering the Harrison Lake drainage system. The chlorination of the treated sewage was to protect the public health while dechlorination was to protect the fisheries resource.

Some biological and chemical testing was done at the plant and/or at our West Vancouver laboratory as part of this study to gain a better understanding of difficulties that might be encountered in the operation of this S.T.P.

The plant has undergone several major modifications in the past several months to improve the operation and prevent plant washouts. The major change was to construct an aerated flow equalization basin to accommodate sudden and prolonged flow increases that previously caused serious problems with the biological operation. Another change was to instal a new chlorine contact chamber and utilize the old chlorine contact chamber as a dechlorination tank.

Before the above modifications were undertaken, excessive flows were a regular occurrence during the tourist season, periods of high rainfall, and the spring thaw. The modifications to the plant provided a near steady state flow that would increase the effectiveness of chlorination and also help with dechlorination. (Table 1 and 2.)

Sampling and Analyses

Bacteriological

Samples were collected in sterile 6 oz jars and processed on site. The membrane filtration (MF) method for fecal coliform analysis was used as outlined in the 15th edition of "Standard Methods". Samples that contained a chlorine residual were collected in "treated" jars, all others were collected in non-treated jars. All samples were processed within 30 minutes of collection and incubated in portable incubators at 44.5°C for 24 hours.

Chemical Analyses

Samples processed on site were tested, using standard Test Kits similar to those that were being used at the treatment plant.

Samples sent to the EPS West Vancouver laboratory for processing were transported under refrigeration at 4 °C.

Observations

1. The plant and grounds were clean and tidy, a small amount of construction spoil is still to be removed as time permits.

2. All aeration laterals in the aeration basin were working. No offensive odor was noticed at any plant location.

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3. The influent enters a scum collection basin from a typical force main There was a slight musty odor when the main was discharging.

4. The liquor is well mixed, odorless and brown.

5. The digestor appears to be functioning properly, a clean supernatant is flowing over the weir.

6. The sulphite feed line to the dechlorination chamber is an unsecured garden type hose that does not feed to the head of the tank.

7. Records of the plant operation are well kept.

8. Chlorination is done manually as the flow sensor is not operating properly.

9. The S.T.P. laboratory is well equipped and has most of the test kits to provide accurate results for plant operation. A realistic schedule of testing is used.

10. The drying bed is full of partially digested sludge.

11. An inspection of the immediate foreshore did not reveal any indication of problems associated with the integrity of the outfall pipe.

Discussion of Results

The analytical results obtained on site are presented in Tables (1-5). The results of the chlorination/dechlorination vary from unsatisfactory (Oct. 7) to excellent (Oct. 14). The wide range of results indicate that the use of a chlorine testing kit to control the dechlorination portion of the plant is inadequate. The failure of the flow sensing device for chlorine adds an unwanted burden to the plant operator's duties. The failure of these automated units is a most common occurrence at small treatment facilities throughout North America. The plant operator sets the feed pumps for chlorine and sulphite by the hand mode. This method of feeding reagents is adequate when the plant produces an acceptable product but has inherent dangers when the plant fails to perform properly (e.g. bulking-under chlorination - etc.).

The second day of testing proved conclusively that the chlorination/dechlorination mode will work. The effluent was disinfected then dechlorinated in an acceptable manner. (Table 2.)

The sulphite residual remained between 1.0 and 7.0 mg/l during the day. Some variation in the results obtained were due to:

1. Increase in plant flow (operator choice)
2. Power interruption while testing the portable standby generator.

Chlorine dosages varied between 3.0 and 6.0 mg/l dependent on the flow.

Oct 7 flow 120,000 gals - 6 lbs chlorine added/day
Oct 14 flow 200,000 gals - 6 lbs chlorine added/day

The manual application of 6 lbs chlorine per day without regard to flow may account for some of the difficulties during our inspection on October 7, 1982. Prior to the October 14 inspection, the operator was contacted by phone and the control of chlorine and sulphite was discussed. As a result of our discussions the October 14/82 inspection was successful.

Biological Treatment Section

The results of the limited testing of the aeration chamber and clarifier are presented in Tables 3 and 5. The settling characteristics of the mixed liquor is poor, probably the result of the change from summer to the fall operation dramatically reducing the food entering the plant. The food to micro-organism (F/M) ratios calculated on October 7 and October 14 were 0.02 and 0.01 respectively. Normal F/M ratios for activated sludge plants range from 0.3 to 0.4 - lower ratios usually cause problems, such as bulking, when a filamentous growth occurs. The filamentatious material is extremely slow in settling in the clarifier section and often goes over the Weir, resulting in extra chlorine having to be added to destroy the organic material before disinfection can be accomplished. Figure 2 contains a clear path where typical plant settling rate curves would fall. The Harrison plant settling rate curve is plotted in the upper portion of Fig. 2, settling rates in this area indicate a young sludge age, this is consistent with other data and observations made during this inspection.

Influent and Effluent

The tabulated results (Table 4) support the suspected low food levels entering the plant during the fall season. The effluent BOD and NFR are low - indications the biological process is working. The poor settling rate is obviously offset by an extremely clear supernatant in the clarifier. At present the BOD reduction (96% AV) and the NFR reduction (83% AV) are very good and should meet the objectives of most people concerned.

Some suggested changes could be:

1. Increase the sludge recycle rate.
2. Lower the oxygen in the aeration chamber.
3. Lower the oxygen in the flow equalization basin.
4. Periodic sulphite testing.
5. Install a small baffle at the head of the dechlorination tank that would change the velocity of the flow at the point of sulphite application.

Appended for information only is a copy of the Settling Test, S.V.I. and S.D.I. from the Ontario Ministry of the Environment Training Manual on "Basic Sewage Treatment Plant Operations".

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CONCLUSIONS

It is concluded from this inspection and from the analyses done on various stages of the Harrison Hot Springs sewage treatment plant that:

1. A positive sulphite residual can be obtained at the plant. Studies by Servizi and Martens, Carins & Coan conclude that dechlorination effectively removes chlorine induced toxicity and that sulphite residuals as great as 10 mg/l were not lethal (Ref 1,2).

2. Poor settling characteristics of the mixed liquor is due to a low F/M ratio at the plant (Ref 3).

3. The use of a sulphite measuring kit will help to control the amount of sulphite reagent required to counteract the excess chlorine residual from the chlorine contact chamber.

4. An improved method of mixing the sulphite with the chlorinated effluent is required to make efficient use of the contact period within the dechlorination chamber.

5. A cover over the sludge drying bed will promote rapid drying of the treated sludge.

6. The plant produces a high quality effluent.

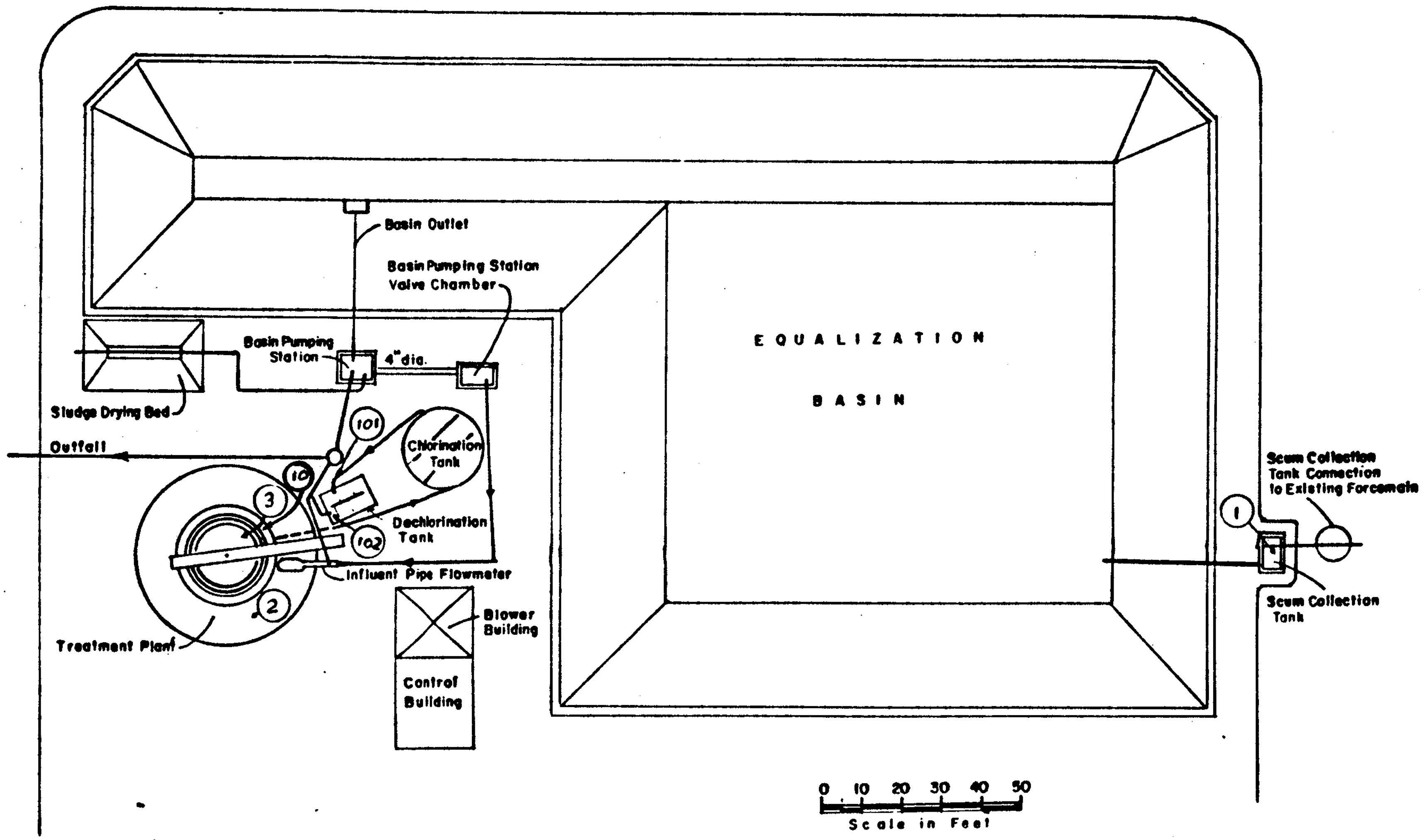

FIGURE 1 VILLAGE OF HARRISON HOT SPRINGS SEWAGE TREATMENT PLANT

TABLE 1 CHLORINATION/DECHLORINATION TESTING

Date Time	Chlorinated Effluent (101)		Dechlorinated Effluent (102)	
	Total Chlorine Res.	Free Chlorine	Total Chlorine Res.	Sulphite
Oct 7/82 11:00*	1.2	-	0.36	0
12:30	1.0	-	0.35	0
13:45	0.6	-	0.08	0
Oct 14/82 11:00**	0.7	0.40	0	1
11:15	0.7	0.30	0	-
12:00	0.8	0.10	0	2
13:00	0.8	0.25	0	5
14:00	0.9	0.25	0	7

* Operator reduced chlorine dosage

** Flow increased to 250,000 gals/day that morning.

N.B. Average chlorine use 6#/day.

TABLE II FECAL COLIFORM DENSITY

DATE & TIME		SAMPLE STATION NUMBERS				Cl.2	Sulphite
		1	10	101	102	Res.	Res.
Oct 7	11:00	11.9×10^{7}	6.2×10^{4}	5	2	1.2	0
	12:30			5	2	1.0	0
	13:45			4	2	0.6	0
Oct 14	11:00	3.1×1^{7}	1.1×10^{5}	8	182	0.4	1
	11:15			4	110	0.3	-
	12:00			6	150	0.1	2
	13:00			6	118	0.25	5
	14:00			5	111	0.25	7

TABLE 3 PLANT ON-SITE CHEMICAL TESTING - OCTOBER 14/82

SAMPLE STATION	pH	TEMP	D.O.	SETTLEABILITY	COLOR	ODOR
1	7.5	15.0	1.5	-	Grey	Musty
2	-	15.0	5.0	10% *	Fluffy Brown	None
3	-	15.0	4.2	-	Clear	None
10	7.0	15.0	4.0	-	Clear	None
101	-	15.0	-	-	Clear	Chlorine
102	-	15.0	-	-	Clear	None

* Poor

TABLE 4 PLANT TESTING - LABORATORY TESTING

DATE	SAMPLE SITE	PHOSPHATE TOTAL	NITRATE (N)			N.F.R.	BOD (5)
			NO_2	NO_3	NH_3		
Oct 7	1	5.71	0.019	<0.01	17.0	152	51
	10	4.01	0.022	15.8	0.311	40	10
Oct 14	1	7.05	0.018	0.01	-	224	156
	10	4.06	0.111	16.8	-	24	5
	2	-	-	-	-	3750	-

TABLE 5 Settling Rates of Mixed Liquor

Time	Measured Settled Volume	% Settled Solids
5	960	96
10	950	95
15	940	94
20	920	92
25	900	90
30	900	90

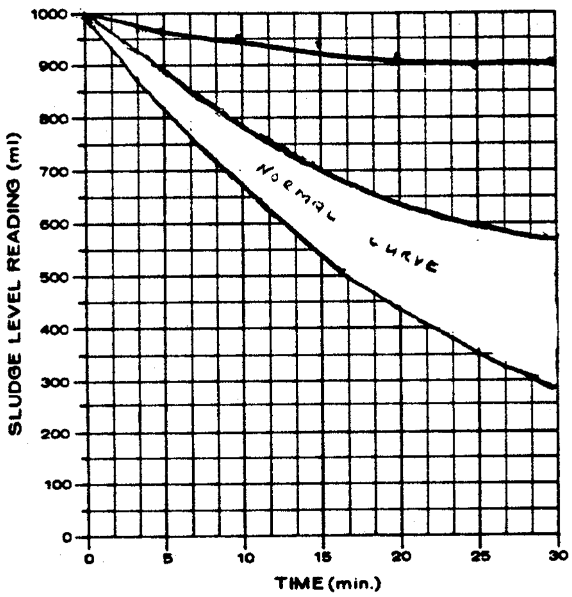

FIGURE 2 SETTLING CURVE FOR 30-MINUTE SETTLING TEST RESULTS

TABLE 6 Sample Station Locations

1. Raw sewage-composite
2. Mixed Liquor-Grab samples
3. Clarifier surface-grab samples
10. Unchlorinated effluent-composite
101. Chlorinated effluent-grab samples.
102. Dechlorinated effluent-grab samples.

References

1. Carins, V.W. and Coan, K 1979 "Acute Lethality of Wastewater Disinfection Alternatives to Juvenile Rainbow Trout" Canada - Ontario Agreement on Great Lakes Water Quality Research. Report No. 92 Ottawa, Ontario.

2. Martens, D.W. and Servizi, J.A. 1975, "Dechlorination of Municipal Sewage using Sulphur Dioxide" International Pacific Salmon Fisheries Commission Progress Report No. 32 New Westminster, B.C.

3. "Basic Sewage Treatment" Ministry of the Environment, Toronto, Ontario.

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SETTLING TEST

GENERAL

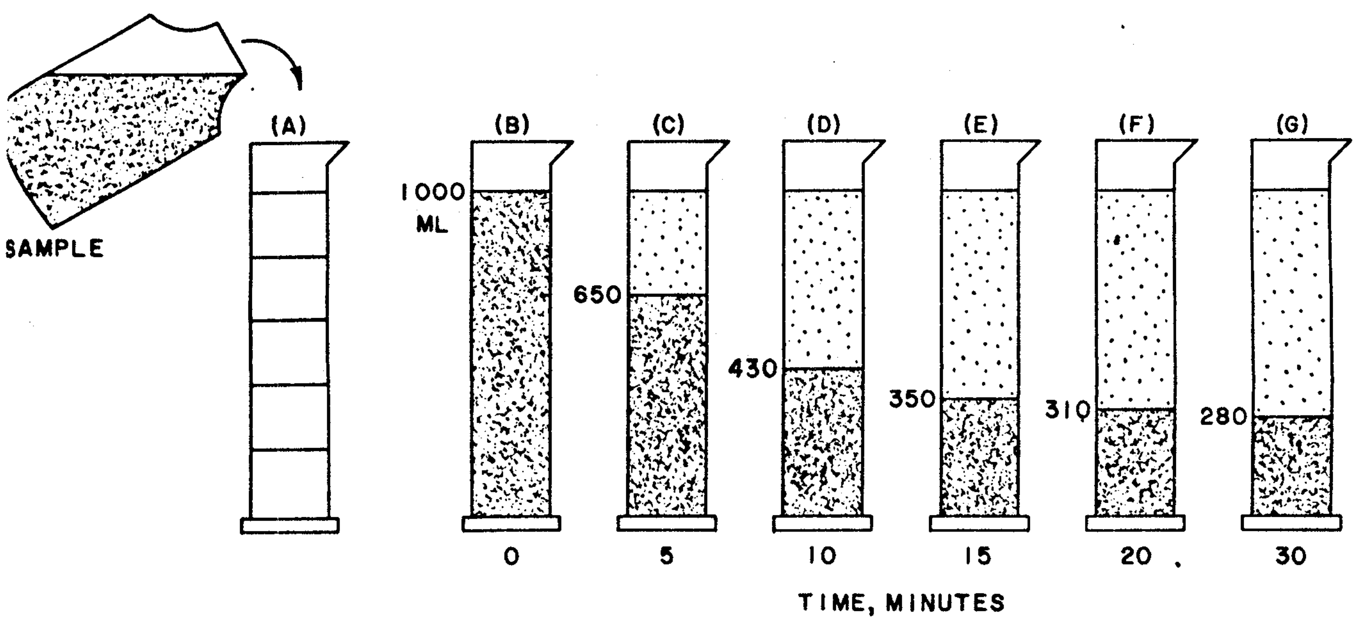
The 30-minute settling test is conducted on mixed liquor to determine the ability of the solids to separate from the liquid in the final clarifier, since the quality of effluent is dependent upon the absence of solids flowing over the effluent weir. The results of the settling test are also used, together with the suspended solids test, to determine sludge volume index. The suspended solids test and settling test should be run on the sample of mixed liquor. This will allow calculation of the Sludge Volume Index (SVI) or the Sludge Density Index (SDI).

The per cent settling rate can be compared for the various days of the week and with other measurements - suspended solids, SVI and per cent sludge solids returned, to provide a record of plant performance and a basis for process control.

APPARATUS

1,000 ml graduated cylinder.

30-minute timer or watch.



PROCEDURE

1. Collect a sample of mixed liquor or return sludge.
2. Gently mix sample and pour into 1,000 ml graduated cylinder. (Vigorous shaking or mixing tends to break up floc and produces slower settling or poorer separation).
3. Record settling solids at 5-minute intervals on a line graph. See Appendix A.
4. Calculate % settleable solids - e.g. In Figure 11-1, % settleable solids after 15 minutes is

$$\frac{350}{1,000} \times 100 = 35\%$$

5. Plot % settleable solids on graph. See Figure 11-2.

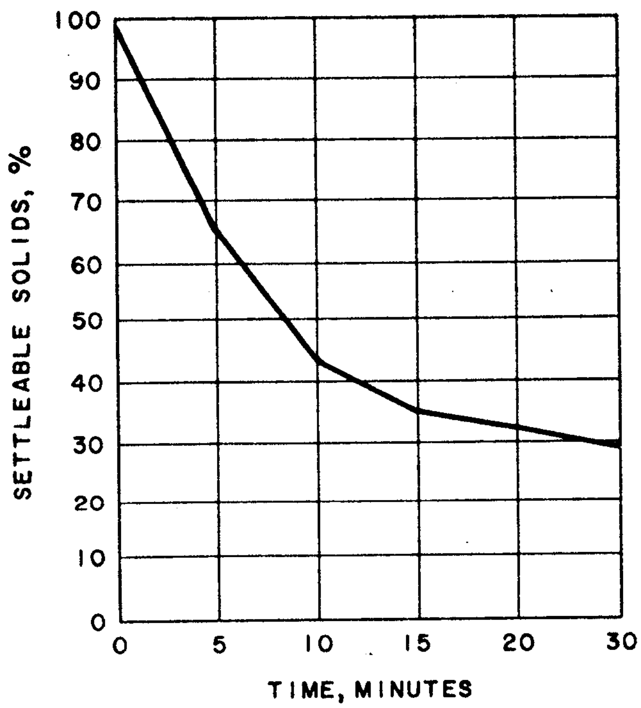


Figure 11-2 Graph Showing Settling of Activated Sludge Solids.

<u>*Note:*</u> *If a cold sample of mixed liquor containing a high DO level (typically a winter condition) is allowed to warm up significantly during this test, the sludge may rise due to the desolubilization of gases. The test must then be repeated in a location where the sample will not warm up significantly.*

SLUDGE VOLUME INDEX (SVI)

The Sludge Volume Index (SVI) is used to indicate the condition of sludge (aeration solids or suspended solids) for settling in a secondary or final clarifier. The SVI is the *volume* in ml occupied by one gram of mixed liquor suspended solids after 30 minutes of settling. It is a useful test to indicate changes in sludge characteristics. The proper SVI range for a plant is determined at the time when the final effluent is in the *best* condition regarding solids and BOD removals and clarity.

Example

Using a 1,000 ml cylinder, after 30 minutes settled solids = 180 ml or 18%.

Mixed liquor suspended solids = 1,500 mg/l.

Calculations

$$\text{Sludge Volume Index (SVI)} = \frac{\text{\% Settleable Solids} \times 10{,}000}{\text{Mixed Liquor Suspended Solids, mg/l}}$$

$$= \frac{18 \times 10{,}000}{1{,}500}$$

$$= \frac{1{,}800}{15}$$

$$= 120$$

SLUDGE DENSITY INDEX (SDI)

The Sludge Density Index (SDI) is used in a way similar to the SVI to indicate the settleability of a sludge in a secondary clarifier or effluent. The calculation of the SDI requires the same information as the SVI test.

$$SDI = 100/SVI$$